Public Health Nutrition: 18(12), 2183–2190 doi:10.1017/S136898001400305X

Large proportions of overweight and obese children, as well as their parents, underestimate children's weight status across Europe. The ENERGY (EuropeaN Energy balance Research to prevent excessive weight Gain among Youth) project

Yannis Manios[1,*], George Moschonis[1], Kalliopi Karatzi[1], Odysseas Androutsos[1], Mai Chinapaw[2], Luis A Moreno[3], Elling Bere[4], Denes Molnar[5], Natasha Jan[6], Alain Dössegger[7], Ilse De Bourdeaudhuij[8], Amika Singh[9] and Johannes Brug[9] on behalf of the ENERGY Consortium

[1]Department of Nutrition and Dietetics, Harokopio University, 70 El Venizelou Avenue, 17671 Kallithea, Athens, Greece: [2]Department of Public and Occupational Health and EMGO Institute for Health and Care Research, VU University Medical Center, Amsterdam, The Netherlands: [3]GENUD (Growth, Exercise, Nutrition and Development) Research Group, EU Ciencias de la Salud, Universidad de Zaragoza, Zaragoza, Spain: [4]Department of Public Health, Sport and Nutrition, University of Agder, Kristiansand, Norway: [5]Department of Paediatrics, University of Pecs, Pecs, Hungary: [6]Slovenian Heart Foundation, Ljubljana, Slovenia: [7]Swiss Federal Institute of Sport, Magglingen, Switzerland: [8]Department of Movement and Sport Sciences, Faculty of Medicine and Health Sciences, Ghent University, Ghent, Belgium: [9]Department of Epidemiology and Biostatistics and EMGO Institute for Health and Care Research, VU University Medical Center, Amsterdam, The Netherlands

Submitted 25 June 2014: Final revision received 7 November 2014: Accepted 17 November 2014: First published online 4 February 2015

Abstract

Objective: To investigate the magnitude and country-specific differences in underestimation of children's weight status by children and their parents in Europe and to further explore its associations with family characteristics and sociodemographic factors.

Design: Children's weight and height were objectively measured. Parental anthropometric and sociodemographic data were self-reported. Children and their parents were asked to comment on children's weight status based on five-point Likert-type scales, ranging from 'I am much too thin' to 'I am much too fat' (children) and 'My child's weight is way too little' to 'My child's weight is way too much' (parents). These data were combined with children's actual weight status, in order to assess underestimation of children's weight status by children themselves and by their parents, respectively. Chi-square tests and multilevel logistic regression analyses were conducted to examine the aims of the current study.

Setting: Eight European countries participating in the ENERGY (EuropeaN Energy balance Research to prevent excessive weight Gain among Youth) project.

Subjects: A school-based survey among 6113 children aged 10–12 years and their parents.

Results: In the total sample, 42·9 % of overweight/obese children and 27·6 % of parents of overweight/obese children underestimated their and their children's weight status, respectively. A higher likelihood for this underestimation of weight status by children and their parents was observed in Eastern and Southern compared with Central/Northern countries. Overweight or obese parents (OR = 1·81; 95 % CI 1·39, 2·35 and OR = 1·78, 95 % CI 1·22, 2·60), parents of boys (OR = 1·32; 95 % CI 1·05, 1·67) and children from overweight/obese (OR = 1·60; 95 % CI 1·29, 1·98 and OR = 1·76; 95 % CI 1·29, 2·41) or unemployed parents (OR = 1·53; 95 % CI 1·22, 1·92) were more likely to underestimate children's weight status.

Conclusions: Children of overweight or obese parents, those from Eastern and Southern Europe, boys, younger children and children with unemployed parents were more likely to underestimate their actual weight status. Overweight or obese parents and parents of boys were more likely to underestimate the actual weight status of their children. In obesity prevention such underestimation may be a barrier for behavioural change.

Keywords
Perceptions of weight status
Childhood obesity
Weight status underestimation

*Corresponding author: Email manios@hua.gr

The prevalence of overweight and obesity in children and adolescents has increased dramatically worldwide[1] and is also high in Europe, more so in Southern European countries[2–4]. Obesity prevention during childhood and adolescence is a public health priority across Europe.

For overweight children and adolescents and their parents to experience a 'need to change' they should be aware of the fact that their weight exceeds recommended levels[5,6]. A deviation between actual and perceived weight status in children and adolescents has been reported repeatedly and in different countries[7–9], and this is more common among overweight and obese individuals[10].

Additionally, results from a recent meta-analysis and a systematic review indicated that two-thirds of overweight children were misperceived by their parents as being of normal weight[11,12]. These data denote that both child and parental underestimation of children's overweight or obese status is highly prevalent among both children and their parents, and thus may be an important constraint of engaging in effective childhood obesity prevention or treatment programmes.

To date it is still unclear to a large extent which factors are associated with the tendency of children and their parents to underestimate children's actual weight status. One important reason may be distortion of body image. More specifically, as more and more children and adolescents live in societies where overweight is more and more prevalent, overweight may be regarded as normal[13]. Gender, parental BMI and ethnicity have previously also been reported as possible factors influencing underestimation of children's abnormal weight status by their parents[14,15].

The present study aimed to investigate the magnitude and country-specific differences in perceptions of children's weight status – as perceived by the children and their parents – and their actual measured weight status in eight European countries with different levels of childhood overweight/obesity. The study also aimed to further explore the associations of family characteristics and sociodemographic factors with underestimation of children's weight status, in order to identify specific population subgroups that primarily need special attention and therefore increase their awareness and active engagement in childhood obesity initiatives.

Experimental methods

Study design and participants

The rationale and conceptualization of the ENERGY (EuropeaN Energy balance Research to prevent excessive weight Gain among Youth) project[16] and a comprehensive description of the design, procedures and methodology of the ENERGY school-based survey[17] have been published elsewhere. Seven countries from the ENERGY Consortium, namely Belgium, Greece, Hungary, the Netherlands, Norway, Slovenia and Spain, participated in the cross-sectional survey. Switzerland joined the Consortium and entered the survey in a later phase[18]. The school-based survey of the ENERGY project was carried out among 10- to 12-year-old children and their parents. The recruitment and data collection took place from March to July 2010 (Belgium, Greece, Hungary, the Netherlands, Norway, Slovenia and Spain) and between June and December 2010 (Switzerland). These countries were selected since they provide variation across regions in Europe and thus variation in potential obesogenic behaviours and prevalence of overweight and obesity. All participating countries obtained ethical approval by the relevant ethical committees and ministries. The project adhered to the Helsinki Declaration and the conventions of the Council of Europe on human rights and biomedicine.

Sampling was national in Greece, Hungary, the Netherlands and Slovenia. In Spain, schools in the region of Aragón were selected; Belgium selected schools from Flanders; Norway selected schools from the southern regions of the country; and Switzerland from the German-speaking part of the country[17]. The sampling of schools was random, multistage and stratified by degree of urbanization in the regions under study. More details on the sampling procedure are presented elsewhere[17]. A school recruitment letter was sent to the headmaster or principal of the participating schools, followed by a personal telephone call. Following the school's approval for participation in the study, parents received a letter explaining the study purpose and were asked to provide a written consent for their child's and their own participation. Detailed information on response rates at school (child and parent level) has been reported elsewhere[19]. In summary a total of 199 schools participated in the study, with 7915 children (response rate 60 %) and 6512 parents (response rate 55 %) completing questionnaires across the eight countries. However, it is important to notice that the population under study consisted of children and their parents with complete data on all variables needed to test the research hypothesis (i.e. objectively measured anthropometric data from children; and self-reported data concerning children's and parental perceptions of children's weight status, parental anthropometrics and family sociodemographic factors). In almost all countries participating in the ENERGY project, complete data were collected from the majority of children and their parents. The only exception was the Netherlands where complete data were available for less than half of the study sample because of lower response rates among parents.

Data collection

Data in all countries were collected according to a standardized protocol[17]. The study included anthropometric measurements as well as completion of a child and a

parent questionnaire[17]. Questionnaires were provided and were filled in by both children and their parents. The data collection protocol and survey questionnaires used for the ENERGY cross-sectional survey are available online (http://projectenergy.eu). Detailed information regarding the development, validity and reliability of the child questionnaire is published elsewhere[17,20,21].

Children's anthropometric measurements

Standing height and body weight measurements were performed by trained research assistants using standard procedures and equipment in all study sites. The intra- and inter-rater reliability for the measurements of weight and height were previously found to be high in the ENERY project[17]. Children were weighed in light clothing without shoes using a Seca digital scale (Seca Alpha, model 861, Hamburg, Germany) with an accuracy of 0·1 kg. Height was measured to the nearest 0·1 cm using a commercial stadiometer (Leicester Height Measure, Invicta Plastics Ltd, Oadby, UK) with children keeping their shoulders in a relaxed position, their arms hanging freely and their head aligned in the Frankfort horizontal plane. Two readings of each measurement were obtained. If the two readings differed more than 1 % then a third measurement was taken. BMI was calculated and the International Obesity Task Force cut-off points[22] were used to categorize participants as underweight, normal weight or overweight/obese.

Data derived from questionnaire

Underestimation of children's actual weight status

Both parents and children were asked to complete a question aiming to evaluate their perception of the child's weight status; parents were also asked their own and their child's weight status, respectively. Children were asked to complete the relevant questionnaire during school time, while parents received the questionnaire and were instructed to complete it at home and return it back to school in a closed envelope.

The question used to assess children's perception of their own weight status was: 'Do you think you are too thin or too fat?', with children having to choose one of the following five answers: 'I am much too thin', 'I am a bit too thin', 'I am nor too thin nor too fat', 'I am a bit too fat' and 'I am much too fat'. The test–retest reliability and the validity of this question have been presented elsewhere[9] and based on the '% level of agreement' values its reliability and validity have been characterized as 'good' and 'moderate', respectively.

The question used for assessing parental perception of their child's weight status was: 'What do you think about your child's weight?', with the possible answer being one of the following five choices: 'My child's weight is way too little', 'My child's weight is a bit too little', 'My child's weight is OK', 'My child's weight is a bit too much' and 'My child's weight is way too much'. The test–retest reliability and the validity of this question have been presented elsewhere[21] and based on the '% level of agreement' values its reliability and validity have been characterized as 'excellent'. For the needs of the current paper, children underestimating their weight were normal-weight children considering themselves as 'much too thin' or 'a bit too thin', and overweight or obese children considering themselves as 'much too thin', 'a bit too thin' or 'nor too thin nor too fat'. Similarly, parents underestimating their child's weight status were those reporting that the weight of their normal-weight child was 'much too little' or 'a bit too little', and those perceiving the weight of their overweight or obese child as 'much too little', 'a bit too little' or 'OK'.

Family sociodemographic factors and parental anthropometrics

Data on family sociodemographic factors obtained in the present study included parental educational level, parental employment status, marital status and ethnic background. The educational level was categorized as: 'both parents <14 years of education' and 'at least one parent ≥14 years of education', distinguishing families with at least one caregiver who has completed medium or higher vocational, college or university training from other families. The parental employment status was categorized as: 'at least one unemployed' and 'both employed'. Family structure was divided into two categories: i.e. 'single-parent family' and 'dual-parent family'. Regarding ethnic background, parents were further categorized as 'native' and 'non-native' based on their country of birth. A dichotomous variable was created, according to the definition of foreign ethnic background used by Statistics Netherlands, distinguishing children from parents who were both born in the country of administration (native) from those for whom at least one parent was born in another country (non-native). Finally, self-reported body weight and height data for the parent who filled in the questionnaire were also collected. These data were used to calculate parental BMI and consequently to categorize parents as 'underweight', 'normal weight', 'overweight' and 'obese' based on the International Obesity Task Force cut-off points.

Statistical analysis

Categorical variables were summarized as relative frequencies (%). Associations between categorical variables were assessed using the χ^2 test. The two-sample z test for proportions was applied for pair-wise comparisons of proportion using the Bonferroni rule to adjust for multiple comparisons. Multilevel (univariate and multivariate) logistic regression analyses were performed, with children nested within classes, nested within schools (three-level random intercept model), in order to assess the statistical significance of the associations of sociodemographic characteristics (independent variables) with children's and parental underestimation of children's actual weight status (dependent variables). The results are presented as odds

ratios and 95 % confidence intervals. All reported *P* values were based on two-sided tests. The level of statistical significance was set at $P < 0{\cdot}05$. The statistical software package IBM SPSS Statistics version 21·0 was used for all statistical analyses.

Results

The estimates of children's and parental perception of children's weight status in the total sample and in each one of the eight European countries participating in the present study are presented in Table 1. According to these data a high percentage of overweight/obese children (42·9 %) were found to underestimate their weight status, with the highest figure observed in Greece (55·9 %) and the lowest in Belgium (21·2 %). Moreover, a high percentage of normal-weight children were also found to underestimate their weight status (25·1 %), with the highest figure observed in Greece (47·9 %) and the lowest one in Norway (13·3 %). Additionally, 27·6 % of parents with overweight or obese children underestimated their children's weight status. The highest percentage of parents underestimating their overweight or their obese children's weight status was observed in Norway (36·4 %), while the lowest was observed in Switzerland (20·3 %). A relatively small percentage of parents (14·2 %) underestimated the weight status in their normal-weight children, with the highest figure reported for Spain (18·0 %).

Table 2 presents the family sociodemographic characteristics that were found to be significantly associated with children's and parental underestimation of children's weight status. More specifically, the multiple analyses including all potential correlates of underestimation showed that a higher likelihood for children underestimating their weight status was observed for children living in Eastern (OR = 2·04; 95 % CI 1·53, 2·73) and Southern European countries (OR = 4·16; 95 % CI 3·21, 5·39) compared with those living in Central/Northern European countries; in boys compared with girls (OR = 1·52; 95 % CI 1·25, 1·85); and children with at least one parent unemployed compared with those whose parents were both employed (OR = 1·53; 95 % CI 1·22, 1·92). Additionally, children of overweight and obese parents were more likely to underestimate their weight status (OR = 1·60; 95 % CI 1·29, 1·98 and OR = 1·76; 95 % CI 1·29, 2·41, respectively); and the likelihood of underestimation of children's weight status decreased with children's age (OR = 0·80; 95 % CI 0·71, 0·91). In accordance, a higher likelihood of parental underestimation of their children's weight status was observed for parents living in Eastern (OR = 1·54; 95 % CI 1·13, 2·11) and Southern (OR = 2·16; 95 % CI 1·61, 2·89) European countries compared with parents living in Central/Northern Europe; for parents of boys compared with parents of girls (OR = 1·32; 95 % CI 1·05, 1·67); and overweight and obese parents were also

Table 1 Overall and country-specific estimates of children's and parental perception of children's weight status among 10- to 12-year-old children in eight European countries; the ENERGY project, 2010

	Children's underestimation of their weight status				Parental underestimation of their children's weight status			
	Normal-weight children considering themselves as too thin/thin		Overweight/obese children considering themselves as too thin/thin/normal		Parents considering the weight of their normal-weight children as too little/little		Parents considering the weight of their overweight/obese children as too little/little/OK	
Country	*n*	%	*n*	%	*n*	%	*n*	%
Total	962	25·1	479	42·9	545	14·2	308	27·6
Belgium (BE)	98	19·4	18	21·2	64	12·7	27	31·8
Greece (GR)	216	47·9	171	55·9	80	17·7	72	23·5
Hungary (HU)	142	28·7	56	33·3	77	15·6	42	25·0
Netherlands (NL)	49	18·8	13	41·9	33	12·7	9	29·0
Norway (NO)	72	13·3	40	45·5	57	10·6	32	36·4
Slovenia (SL)	135	22·8	72	34·6	80	13·5	54	26·0
Spain (ES)	188	31·1	95	55·2	109	18·0	60	34·9
Switzerland (SW)	62	16·2	14	23·7	45	11·8	12	20·3
P value		<0·001		<0·001		0·002		0·057
Differences among countries	GR > ES > HU > SL > BE > NL > SW > NO		GR > SL > HU > SW > BE		GR > NO		–	
	HU > BE > SW > NO		NO > BE		ES > NO			
	SL > NO		ES > SL > HU > SW > BE					
	ES > SL > BE > NL > SW > NO							

P values indicate differences among countries and are derived from χ^2 tests and two-sample *z* test for pair-wise country comparisons of proportion using the Bonferroni rule to adjust for multiple comparisons.

Table 2 Odds ratios and 95 % confidence intervals resulting from multilevel binary multiple logistic regression analyses assessing the relationship between underestimation of children's weight status by 10- to 12-year-old children and their parents and sociodemographic variables and parental weight status, for normal-weight and overweight children; the ENERGY project, 2010

	Dependent variable: Underestimation of children's weight status by children (*n* 4947)		Dependent variable: Underestimation of children's weight status by their parents (*n* 4947)	
	Adjusted OR*	95 % CI	Adjusted OR*	95 % CI
Country				
Central/North	1·00	Ref.	1·00	Ref.
Eastern	**2·04**	**1·53, 2·73**	**1·54**	**1·13, 2·11**
South	**4·16**	**3·21, 5·39**	**2·16**	**1·61, 2·89**
Children's age (years)	**0·80**	**0·71, 0·91**	0·97	0·83, 1·12
Participating parent's age (years)	0·99	0·97, 1·01	0·98	0·96, 1·00
Parental origin				
Non-native	1·00	Ref.	1·00	Ref.
Native	1·03	0·79, 1·33	1·15	0·83, 1·60
Family structure				
Single-parent family	1·00	Ref.	1·00	Ref.
Dual-parent family	0·86	0·52, 1·41	0·62	0·37, 1·04
Parental educational status				
Both parents <14 years of education	1·00	Ref.	1·00	Ref.
At least one parent ≥14 years of education	0·82	0·67, 1·01	0·90	0·70, 1·15
Parental occupational status				
Both employed	1·00	Ref.	1·00	Ref.
At least one unemployed	**1·53**	**1·22, 1·92**	1·16	0·87, 1·545
Children's gender				
Girl	1·00	Ref.	1·00	Ref.
Boy	**1·52**	**1·25, 1·85**	**1·32**	**1·05, 1·67**
Parental BMI status				
Normal	1·00	Ref.	1·00	Ref.
Overweight	**1·60**	**1·29, 1·98**	**1·81**	**1·39, 2·35**
Obese	**1·76**	**1·29, 2·41**	**1·78**	**1·22, 2·60**
Parent who participated in the study				
Mother/stepmother	–	–	1·00	Ref.
Father/stepfather	–	–	1·22	0·88, 1·69

Ref., referent category.
Statistically significant odds ratios are indicated in bold font.
*Adjusted for all other independent variables included in the multivariate logistic regression models.

more likely to underestimate their children's weight status (OR = 1·81; 95 % CI 1·39, 2·35 and OR = 1·78; 95 % CI 1·22, 2·60, respectively; Table 2).

Discussion

The present study focuses on underestimation of children's actual weight status by children themselves as well as by their parents using data from eight European countries. Such underestimation may be of importance because children and parents who underestimate the child's weight status may be less motivated and willing to engage behaviours and activities that contribute to obesity prevention.

The current study showed a high percentage of underestimation of children's weight status by children themselves and their parents in the eight countries participating in the ENERGY project. Underestimation of children's actual weight status was related to several family characteristics and sociodemographic factors, with region, children's gender, parental occupational status and parental weight status being the most important ones.

Underestimation of children's actual weight status by both children and their parents has been described previously and seems to be quite common in developed countries[11,23]. Data from large epidemiological studies or review articles have shown that underestimation of children's and adolescents' weight status by themselves and by their parents is relatively high[24–26]. However, there are remarkable discrepancies in the results of published studies, which could be attributed to differences in study populations in terms of country, age, sex and socio-economic status[12,27–32]. The present study moved beyond not just assessing the magnitude of underestimation in eight European countries, but also tried to explore and understand the role of the country, age, sex, socio-economic status and parental weight status in explaining differences in underestimation of children's weight status.

In the total sample, close to half of overweight and obese children underestimated their own weight status, with the highest figures (i.e. more than half of the respondents underestimating their weight status) observed in Spain and Greece. These proportions are much higher than the percentage presented by similar previous studies, reporting 30 % misconception that also included some overestimation of weight status in underweight children[8,9,23]. These studies were conducted in children

and adolescents from the USA, Canada and Australia, while our findings are from a sample of European countries, which implies the possible effect of cultural or other factors on the correct perception of actual weight status among children and adolescents. Of course, the different qualitative tools and questions used for assessing perceptions in these studies and should be kept in mind when interpreting these results.

Several correlates of children's weight status underestimation by children themselves or by their parents were also reported in the present study. It seems that country, children's age and gender, parental overweight status as well as parental employment status were the strongest correlates leading both children and their parents to underestimate the actual weight status in normal-weight, overweight and obese children.

Regarding the association observed between country of residence and underestimation of children's actual weight status by both children and their parents, it could probably be related to regional differences in the prevalence of childhood and adulthood obesity among different European countries. It is already described that the prevalence of obesity among children, adolescents and adults is higher in Southern and Eastern Europe, compared with Central and Northern Europe[19,33]. As it is more likely for overweight and obese children and adults to underestimate their increased body weight compared with their normal-weight counterparts[8,14], it seems rather reasonable that in the countries within Europe with a higher prevalence of overweight and obesity, the highest percentages of underestimation of children's weight status also coexist.

Additionally, it is already described that overweight or obese parents and their children are more likely to underestimate children's normal or excess body weight[8,14]. Children exposed to an obesogenic environment are usually those having overweight and obese parents and/or siblings, and this probably increases their tendency to perceive high BMI as normal[8,13]. The same argument also stands for parents. It has been previously discussed that overweight and obese parents have established a distorted body image which is shifted to overweight, thus leading them to misperceive their children's increased BMI[13,14]. Additionally, it has been suggested that parents may subconsciously or consciously but systematically avoid characterizing their children as overweight, for fear of having their children stigmatized or being blamed by health professionals for their child's excess body weight problem[26,34].

Gender and age also appeared as significant correlates of children's weight status underestimation. Boys themselves and parents of boys tended to underestimate to a higher extent boys' increased body weight compared with girls and parents of girls, respectively. This finding is in accordance with previous findings[9,32,35] and is usually explained by the fact that female adolescents are more concerned with their body image than male adolescents, enabling girls to more correctly classify themselves based on their weight status[36]. On the other hand, parents often explain body size differences between girls and boys as normal gender differences and in this context they also may be influenced by the social desirability for a lower body weight in girls and for a larger body size in boys. This can ultimately lead them to correctly perceive an overweight girl, but simultaneously to misperceive an overweight boy as an early developed, normal-weight child[32,35,37].

Our findings also showed that children's underestimation of their weight status decreased as their age increases, which is quite reasonable as increased age brings maturity and a better capability to understand their body image and body size. Additionally, children having at least one parent unemployed were more likely to underestimate their weight status compared with children with both parents employed. This is in line with earlier findings, as it is previously described that socio-economic factors associate with children's perception of their weight status[9], with children from families of low socio-economic status being more likely to underestimate weight status.

The present study has both strengths and limitations. One of its major strengths is the large sample size obtained from eight European countries. Additionally, the use of a standardized protocol for data collection and data processing, and the objectively measured weight and height in children, are also important strengths of the study. Regarding limitations, parental weight and height were self-reports and consequently subjectivity might have influenced the results. Additionally, weight status underestimation was assessed based on questions concerning estimation of a child's weight being too much, rather than questions about a child being overweight or obese. However, the first type of questions was preferred in order not to stigmatize children of abnormal body weight. Furthermore, due to the cross-sectional design of the study a cause-and-effect relationship cannot be identified. Another limitation could be considered the apparent differences in school, student and parent response rates. The response rates at the student level were generally very high, but lower response rates were observed at the school and parent levels. This was particularly the case in the Netherlands, which is most probably caused by the fact that Dutch schools already participate in obligatory school-based research by municipal health services and the related reluctance to participate in any additional school-based research. Therefore, although the Dutch results are in line with other data regarding overweight and obesogenic behaviours in this age group, the Dutch data should be interpreted with more caution. Additionally, in Hungary, Norway and Spain active instead of passive informed consent of parents was needed, which has led to lower response rates in these countries.

Conclusion

In conclusion, a considerably high percentage of children and their parents were found to underestimate children's weight status in several European countries. Children of overweight and obese parents and their parents, those from Southern or Eastern countries, younger children, boys, parents of boys and children of unemployed parents were more likely to underestimate children's weight status compared with their respective counterparts. The findings of the current study should guide any future public health initiative in developing and implementing interventions in a most efficient way. Initiatives aiming to prevent or treat obesity should primarily target those population subgroups to increase their awareness, participation and active engagement.

Acknowledgements

Financial support: The ENERGY project is funded by the Seventh Framework Programme (CORDIS FP7) of the European Commission, HEALTH (FP7-HEALTH-2007-B). The content of this article reflects only the authors' views and the European Community is not liable for any use that may be made of the information contained therein. *Conflict of interest:* None. *Authorship:* Y.M., J.B., M.C., A.S. and E.B. designed the international study. All authors contributed to the development of measurement protocols and instruments and coordinated and supervised the data collection in the participating countries. Y.M., G.M., K.K. and O.A. conducted the analyses. Y.M. drafted the manuscript. All authors provided input for the first draft and provided feedback on drafts before submission. All authors approved the submitted manuscript. *Ethics of human subject participation:* All participating countries obtained ethical approval by the relevant ethical committees and ministries. The project adhered to the Helsinki Declaration and the conventions of the Council of Europe on human rights and biomedicine.

References

1. World Health Organization (2014) Commission on Ending Childhood Obesity. Facts and figures on childhood obesity. http://www.who.int/end-childhood-obesity/facts/en/
2. Brug J, van Stralen MM, Chinapaw MJ *et al.* (2012) Differences in weight status and energy-balance related behaviours according to ethnic background among adolescents in seven countries in Europe: the ENERGY-project. *Pediatr Obes* **7**, 399–411.
3. Verloigne M, Bere E, Van Lippevelde W *et al.* (2012) The effect of the UP4FUN pilot intervention on objectively measured sedentary time and physical activity in 10–12 year old children in Belgium: the ENERGY-project. *BMC Public Health* **12**, 805.
4. Costarelli V & Manios Y (2009) The influence of socio-economic status and ethnicity on children's excess body weight. *Nutr Food Sci* **39**, 676–684.
5. Young PC, DeBry S, Jackson WD *et al.* (2012) Improving the prevention, early recognition, and treatment of pediatric obesity by primary care physicians. *Clin Pediatr (Phila)* **49**, 964–969.
6. Moore LC, Harris CV & Bradlyn AS (2012) Exploring the relationship between parental concern and the management of childhood obesity. *Matern Child Health J* **16**, 902–908.
7. Jansen W, van de Looij-Jansen PM, Ferreira I *et al.* (2006) Differences in measured and self-reported height and weight in Dutch adolescents. *Ann Nutr Metab* **50**, 339–346.
8. Maximova K, McGrath JJ, Barnett T *et al.* (2008) Do you see what I see? Weight status misperception and exposure to obesity among children and adolescents. *Int J Obes (Lond)* **32**, 1008–1015.
9. Park E (2011) Overestimation and underestimation: adolescents' weight perception in comparison to BMI-based weight status and how it varies across socio-demographic factors. *J Sch Health* **81**, 57–64.
10. Kuchler F & Variyam JN (2003) Mistakes were made: misperception as a barrier to reducing overweight. *Int J Obes Relat Metab Disord* **27**, 856–861.
11. Mareno N (2013) Parental perception of child weight: a concept analysis. *J Adv Nurs* (Epublication ahead of print version).
12. Rietmeijer-Mentink M, Paulis WD, van Middelkoop M *et al.* (2013) Difference between parental perception and actual weight status of children: a systematic review. *Matern Child Nutr* **9**, 3–22.
13. Binkin N, Spinelli A, Baglio G *et al.* (2013) What is common becomes normal: the effect of obesity prevalence on maternal perception. *Nutr Metab Cardiovasc Dis* **23**, 410–416.
14. Hudson E, McGloin A & McConnon A (2012) Parental weight (mis)perceptions: factors influencing parents' ability to correctly categorise their child's weight status. *Matern Child Health J* **16**, 1801–1809.
15. Jansen W & Brug J (2006) Parents often do not recognize overweight in their child, regardless of their socio-demographic background. *Eur J Public Health* **16**, 645–647.
16. Brug J, te Velde SJ, Chinapaw MJ *et al.* (2010) Evidence-based development of school-based and family-involved prevention of overweight across Europe: the ENERGY-project's design and conceptual framework. *BMC Public Health* **10**, 276.
17. van Stralen MM, te Velde SJ, Singh AS *et al.* (2011) EuropeaN Energy balance Research to prevent excessive weight Gain among Youth (ENERGY) project: design and methodology of the ENERGY cross-sectional survey. *BMC Public Health* **11**, 65.
18. Herzig M, Dossegger A, Mader U *et al.* (2012) Differences in weight status and energy-balance related behaviors among schoolchildren in German-speaking Switzerland compared to seven countries in Europe. *Int J Behav Nutr Phys Act* **9**, 139.
19. Brug J, van Stralen MM, te Velde SJ *et al.* (2012) Differences in weight status and energy-balance related behaviors among schoolchildren across Europe: the ENERGY-project. *PLoS One* **7**, e34742.
20. Singh AS, Vik FN, Chinapaw MJ *et al.* (2011) Test–retest reliability and construct validity of the ENERGY-child questionnaire on energy balance-related behaviours and their potential determinants: the ENERGY-project. *Int J Behav Nutr Phys Act* **8**, 136.
21. Singh AS, Chinapaw MJ, Uijtdewilligen L *et al.* (2012) Test–retest reliability and construct validity of the ENERGY-parent questionnaire on parenting practices, energy balance-related behaviours and their potential behavioural determinants: the ENERGY-project. *BMC Res Notes* **5**, 434.
22. Fehily AM, Coles RJ, Evans WD *et al.* (1992) Factors affecting bone density in young adults. *Am J Clin Nutr* **56**, 579–586.

23. Khambalia A, Hardy LL & Bauman A (2012) Accuracy of weight perception, life-style behaviours and psychological distress among overweight and obese adolescents. *J Paediatr Child Health* **48**, 220–227.
24. Doolen J, Alpert PT & Miller SK (2009) Parental disconnect between perceived and actual weight status of children: a metasynthesis of the current research. *J Am Acad Nurse Pract* **21**, 160–166.
25. Hearst MO, Sherwood NE, Klein EG *et al.* (2011) Parental perceptions of their adolescent's weight status: the ECHO study. *Am J Health Behav* **35**, 248–255.
26. Towns N & D'Auria J (2009) Parental perceptions of their child's overweight: an integrative review of the literature. *J Pediatr Nurs* **24**, 115–130.
27. Juliusson PB, Roelants M, Markestad T *et al.* (2011) Parental perception of overweight and underweight in children and adolescents. *Acta Paediatr* **100**, 260–265.
28. Moschonis G, Iatridi V, Mavrogianni C *et al.* (2011) Accuracy and correlates of visual and verbal instruments assessing maternal perceptions of children's weight status: the Healthy Growth Study. *Public Health Nutr* **14**, 1979–1987.
29. Parry LL, Netuveli G, Parry J *et al.* (2008) A systematic review of parental perception of overweight status in children. *J Ambul Care Manage* **31**, 253–268.
30. Jones AR, Parkinson KN, Drewett RF *et al.* (2011) Parental perceptions of weight status in children: the Gateshead Millennium Study. *Int J Obes (Lond)* **35**, 953–962.
31. Regber S, Novak M, Eiben G *et al.* (2013) Parental perceptions of and concerns about child's body weight in eight European countries – the IDEFICS study. *Pediatr Obes* **8**, 118–129.
32. Manios Y, Kondaki K, Kourlaba G *et al.* (2009) Maternal perceptions of their child's weight status: the GENESIS study. *Public Health Nutr* **12**, 1099–1105.
33. Berghofer A, Pischon T, Reinhold T *et al.* (2008) Obesity prevalence from a European perspective: a systematic review. *BMC Public Health* **8**, 200.
34. Edmunds LD (2005) Parents' perceptions of health professionals' responses when seeking help for their overweight children. *Fam Pract* **22**, 287–292.
35. Campbell MW, Williams J, Hampton A *et al.* (2006) Maternal concern and perceptions of overweight in Australian preschool-aged children. *Med J Aust* **184**, 274–277.
36. Standley R, Sullivan V & Wardle J (2009) Self-perceived weight in adolescents: over-estimation or under-estimation? *Body Image* **6**, 56–59.
37. Maynard LM, Galuska DA, Blanck HM *et al.* (2003) Maternal perceptions of weight status of children. *Pediatrics* **111**, 1226–1231.